Spicer® Single Drive Axles

DANA SPICER® Drivetrain Products

Service Manual

S140 Series

AXSM0030

September 2013

General Information

The description and specifications contained in this service publication are current at the time of printing.

Dana reserves the right to discontinue or to modify its models and/or procedures and to change specifications at any time without notice.

Any reference to brand name in this publication is made simply as an example of the types of tools and materials recommended for use and should not be considered an endorsement. Equivalents, if available, may be used.

Important Notice

This symbol is used throughout this manual to call attention to procedures where carelessness or failure to follow specific instructions may result in personal injury and/or component damage.

Departure from the instructions, choice of tools, materials and recommended parts mentioned in this publication may jeopardize the personal safety of the service technician or vehicle operator.

WARNING: Failure to follow indicated procedures creates a high risk of personal injury to the servicing technician.

CAUTION: Failure to follow indicated procedures may cause component damage or malfunction.

IMPORTANT: Highly recommended procedures for proper service of this unit.

NOTE: Additional service information not covered in the service procedures.

TIP: Helpful removal and installation procedures to aid in the service of this unit.

OEM Refer to the OEM vehicle specifications

Always use genuine Spicer replacement parts.

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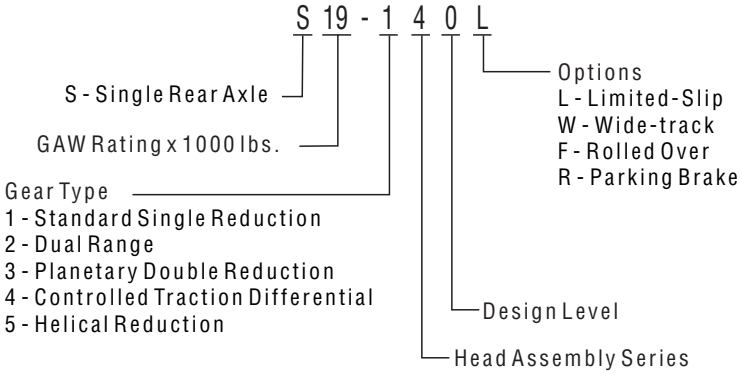
Introduction

Dana Commercial Vehicle Division, presents this publication to aid in maintenance and overhaul of Spicer single drive axles. Instructions contained cover the models listed. Their design is common, with differences in load capacity. Capacity variations are achieved by combining basic differential carrier assemblies with different axle housings, axle shafts and wheel equipment.

Model Listing

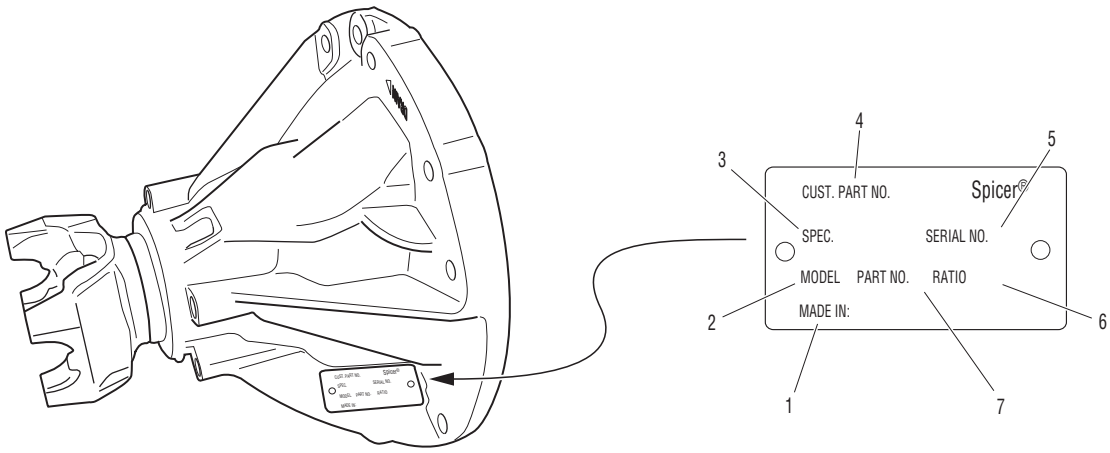
Rear Axle	Load Capacity
S19-140	19,000
S17-140	17,000

Model Information



Model Identification

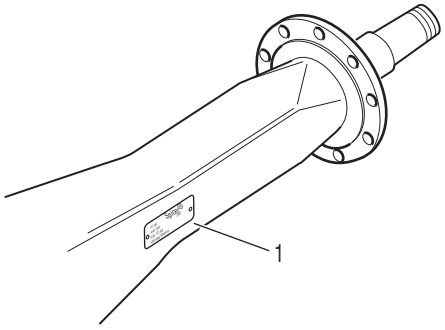
Drive Axle



1 - Country of origin
2 - Axle model identification
3 - Specification number assigned to the axle built by Spicer. Identifies all component parts of the axle including special OEM requirements such as yokes or flanges.
4 - OEM part number assigned to the axle build
5 - Carrier assembly serial number assigned by the manufacturing plant
6 - Axle gear ratio
7 - Carrier assembly production or service part number

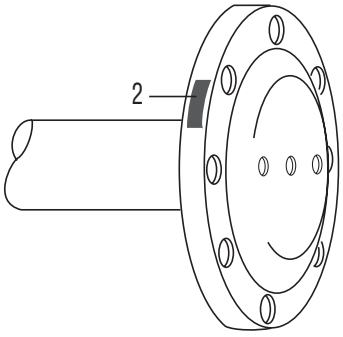
Part Identification

Axle Housing



1 - ID Tag

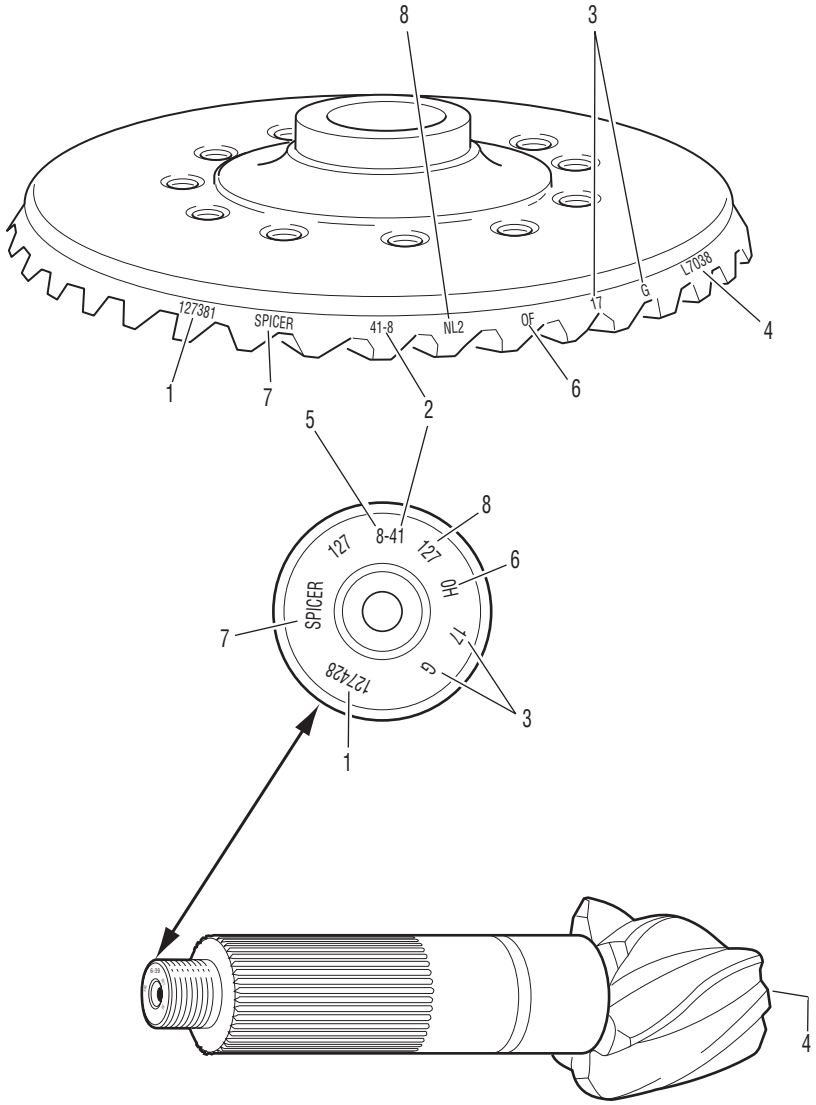
Axle Shaft



2 - Axle shaft part number

Ring Gear and Pinion

Note: Ring gear and drive pinion are matched parts and must be replaced in sets.



1 - Part number
2 - Number of ring gear teeth
3 - Manufacturing numbers
4 - Matching gear set number
5 - Number of pinion teeth
6 - Date code
7 - Indicates genuine Spicer parts
8 - Heat Code

Inspection

Failure Analysis

Failure analysis is the process of determining the original cause of a component failure in order to keep it from happening again. Too often, when a failed component is replaced without determining its cause, there will be a recurring failure. If a carrier housing is opened, revealing a ring gear with a broken tooth, it is not enough to settle on the broken tooth as the cause of the carrier failure. Other parts of the carrier must be examined. For a thorough understanding of the failure and possible insight into related problems, the technician needs to observe the overall condition of the vehicle.

No one benefits when a failed component goes on the junk pile with the cause unknown. Nothing is more disturbing to a customer than a repeat failure. Systematically analyzing a failure to prevent a repeat occurrence assures quality service by avoiding unnecessary downtime and further expense to the customer.

The true cause of a failure can be better determined by knowing what to look for, determining how a piece of the equipment was running and learning about previous problems. In the case of a rebuilt rear axle, mismatched gears may have been installed. The more successful shops prevent repeat equipment failures by developing good failure analysis practices. Knowing how to diagnose the cause of a premature failure is one of the prerequisites of a good heavy-equipment technician.

How to Diagnose a Failure

The following five steps are an effective approach to good failure diagnostics.

1. Document the problem.
2. Make a preliminary investigation.
3. Prepare the parts for inspection.
4. Find the cause of the failure.
5. Correct the cause of the problem.

Document the Problem

Here are some guidelines for starting to learn about a failure, including questions to ask:

1. Talk to the operator of the truck.
2. Look at the service records.
3. Find out when the truck was last serviced.
4. Ask: In what type of service is the truck being used?
5. Ask: Has this particular failure occurred before?
6. Ask: How was the truck working prior to the failure?

You need to be a good listener. Sometimes, insignificant or unrelated symptoms can point to the cause of the failure:

7. Ask: Was the vehicle operating at normal temperatures?
8. Ask: Were the gauges showing normal ranges of operation?
9. Ask: Was there any unusual noise or vibration?

After listening, review the previous repair and maintenance records. If there is more than one driver, talk to all of them and compare their observations for consistency with the service and maintenance records. Verify the chassis Vehicle Identification Number (VIN) number from the vehicle identification plate, as well as the mileage and hours on the vehicle.

Make a Preliminary Investigation

These steps consist of external inspections and observations that will be valuable when combined with the results of the parts examination.

1. Look for leaks, cracks or other damage that can point to the cause of the failure.
2. Make note of obvious leaks around plugs and seals. A missing fill or drain plug would be an obvious cause for concern.
3. Look for cracks in the carrier housing (harder to see, but sometimes visible).
4. Does the general mechanical condition of the vehicle indicate proper maintenance or are there signs of neglect?
5. Are the tires in good condition and do the sizes match?
6. If equipped with a torque-limiting device, is it working properly?

During the preliminary investigation, write down anything out of the ordinary for later reference. Items that appear insignificant now may take on more importance when the subassemblies are torn down.

Prepare the Parts for Inspection

After the preliminary investigation, locate the failure and prepare the part for examination. In carrier failure analysis, it may be necessary to disassemble the unit.

1. When disassembling subassemblies and parts, do not clean the parts immediately since cleaning may destroy some of the evidence.
2. When tearing down the drive axle, do it in the recommended manner. Minimize any further damage to the unit.
3. Ask more questions when examining the interior of the carrier. Does the lubricant meet the manufacturer specifications regarding quality, quantity and viscosity? As soon as you have located the failed part, take time to analyze the data.

Find the Cause of the Failure

Here begins the real challenge to determine the exact cause of the failure. Keep in mind that there is no benefit to replacing a failed part without determining the cause of the failure. For example, after examining a failed part and finding that the failure is caused by a lack of lubrication, you must determine if there was an external leak. Obviously, if there is an external leak, just replacing the failed gear is not going to correct the situation.

Another important consideration is to determine the specific type of failure which can be a valuable indicator for the cause of failure. The following pages show different types of failures and possible causes. Use this as a guide in determining types of failures and in correcting problems.

Correct the Cause of the Problem

Once the cause of the problem has been determined, refer to the appropriate service manual to perform the repairs.

Inspection

Clean

1. Wash steel parts with ground or polished surfaces in solvent. There are many suitable commercial solvents available. Kerosene and diesel fuel are acceptable.

⚠ WARNING

Gasoline is not an acceptable solvent because of its extreme combustibility. It is unsafe in the workshop environment.

2. Wash castings or other rough parts in solvent or clean in hot solution tanks using mild alkali solutions.

Note: If a hot solution tank is used, make sure parts are heated thoroughly before rinsing.

3. Rinse thoroughly to remove all traces of the cleaning solution.
4. Dry parts immediately with clean rags.
5. Oil parts.

- If parts are to be reused immediately: Lightly oil.
- If parts are to be stored: Coat with oil, wrap in corrosion resistant paper and store in a clean, dry place.

Inspect Axle Housing

Axle housing inspection and repairs are limited to the following checks or repairs.

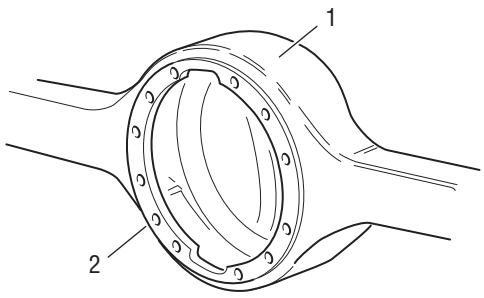
- Visually inspect axle housing for cracks, nicks and burrs on machined surfaces.
- Check carrier bolt holes and studs for foreign material.
- Replace damaged fasteners. Look for loose bolts or cross-threaded holes

⚠ CAUTION

Any damage which affects the alignment or structural integrity of the housing requires housing replacement. Do not repair by bending or straightening. This process can affect the material's properties and cause it to fail completely under load.

- Check all seals and gaskets.

Note: Replace conventional gaskets with silicone rubber gasket compound (included in many repair kits). The compound provides a more effective seal against lube seepage and is easier to remove from mating surfaces when replacing parts.



1 - Axle housing
2 - Machined surface

Inspect Components

Inspect all steel parts for:

- Notches, visible steps or grooves created by wear.
- Pitting or cracking along gear contact lines.
- Scuffing, deformation or discolorations. These are signs of excessive heat in the axle and are usually related to low lubrication levels or improper lubrication practices.

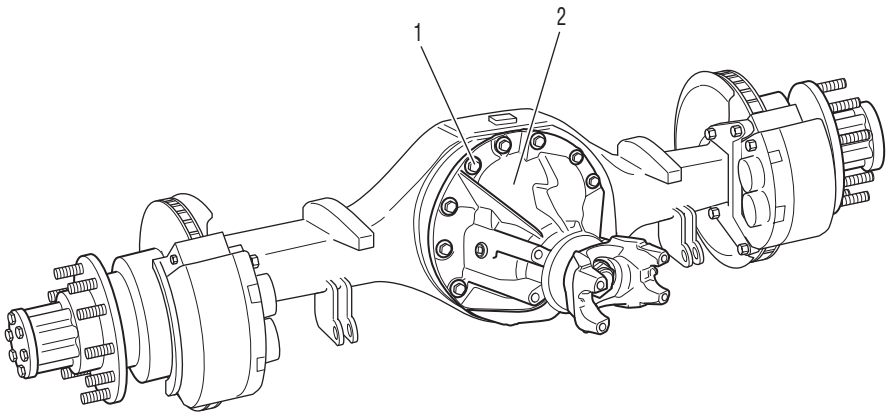
In addition, inspect the following for damage:

- Differential gearing
- Bearings for loose fit on drive pinion, and differential bearings.
- All fasteners for rounded heads, bends, cracks or damaged threads.
- Inspect machined surfaces of cast or malleable parts. They must be free of nicks, burrs, cracks, scoring, and wear.
- Look for elongation of drilled holes, wear on surfaces machined for bearing fits and nicks or burrs in mating surfaces.

Inspect Primary Gearing

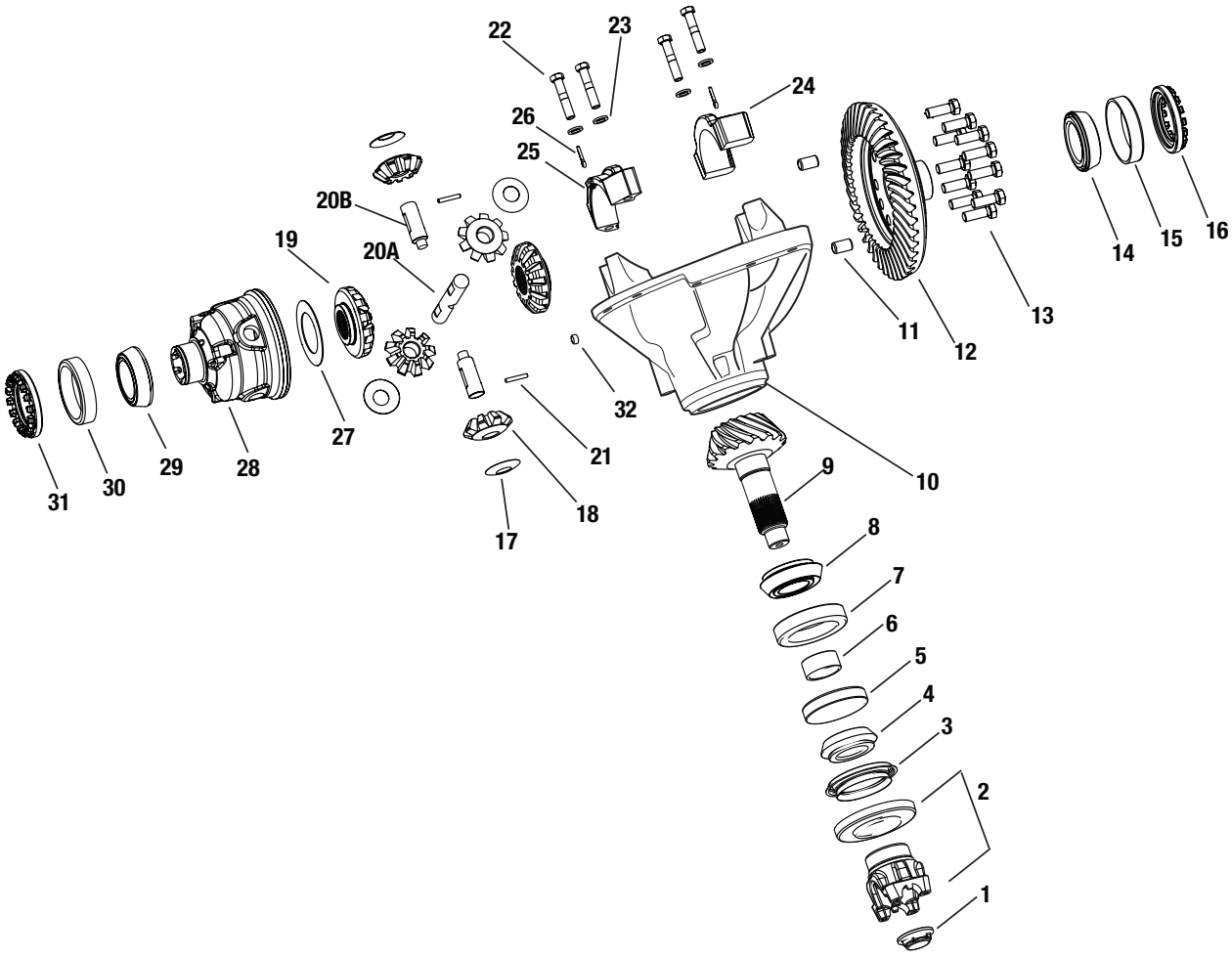
Before reusing a primary gear set, inspect teeth for signs of excessive wear. Check tooth contact pattern for evidence of incorrect adjustment.

Differential Carrier Assembly



1 - Carrier fastener
2 - Carrier assembly

Differential Carrier Assembly - Parts Exploded View



1 - Pinion Nut
2 - End Yoke and Slinger
3 - Oil Seal
4 - Outer Pinion Bearing Cone
5 - Outer Pinion Bearing Cup
6 - Pinion Spacer
7 - Inner Pinion Bearing Cup
8 - Inner Pinion Bearing Cone
9 - Drive Pinion
10 - Carrier Housing
11 - Diff Case Dowels
12 - Ring Gear
13 - Ring Gear Bolts
14 - Flange Half Bearing Cone
15 - Flange Half Bearing Cup
16 - Flange Half Bearing Adjuster
17 - Side Pinion Thrust Washer
18 - Side Pinion
19 - Side Gear
20A,B - Differential Shaft
21 - Pin
22 - Capscrew
23 - Flat Washer
24 - Flange Half Cap
25 - Plain Half Cap
26 - Cotter Pin
27 - Side Gear Thrust Washer
28 - Plain Half Diff Case
29 - Plain Half Bearing Cone
30 - Plain Half Bearing Cup
31 - Plain Half Bearing Adjuster
32 - Pipe Plug

Remove Differential Carrier

Standard Differentials

1. Block the vehicle.
2. Drain axle lubricant. Remove bottom two (2) capscrews.
3. Disconnect driveline.
4. Remove axle shafts. (If used, remove lock washers and taper dowels.)

⚠ WARNING

Do not lie under carrier after fasteners are removed. Use transmission jack to support differential carrier assembly prior to loosening fasteners.

⚠ CAUTION

Do not strike the shaft head with a steel hammer. Do not use chisels or wedges to loosen shaft or dowels.

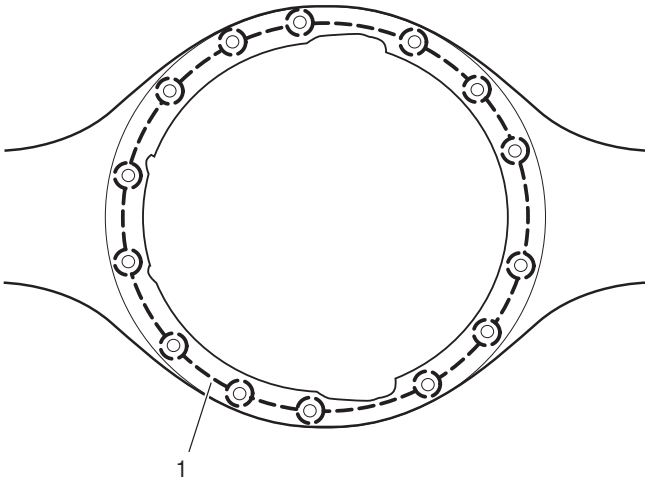
5. Remove carrier capscrews and washers.
6. Remove differential carrier assembly.

Install Differential Carrier

⚠ IMPORTANT

Before installing carrier assembly, inspect and thoroughly clean interior of axle housing using an appropriate solvent and clean rag.

1. Apply Spicer approved RTV compound on axle housing mating surface as shown in the illustration. Completely remove all old gasket material prior to applying new material. Compound will set in 20 minutes. Install carrier before compound sets or reapply.



1 - Apply RTV gasket in this pattern

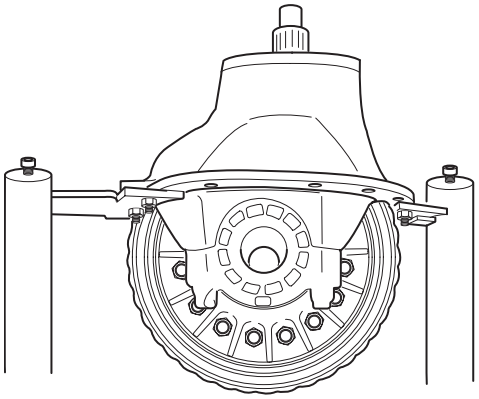
TIP: To assist in installing complete differential carrier use two pieces of threaded rod (M14 X 2) threaded into carrier capscrew holes. Rod should be approximately 4" (102 mm) long. Use these to pilot the carrier into the housing.

2. Install carrier to housing, lock washers and capscrews. Torque to proper specification. Torque to 142–158 lbs. ft. (193–214 N•m).
3. Install axle shafts and axle stud nuts.
4. Add axle lubricant. Fill to bottom of filler hole in carrier.
5. Connect main driveline and lubricate joints.

Remove Wheel Differential

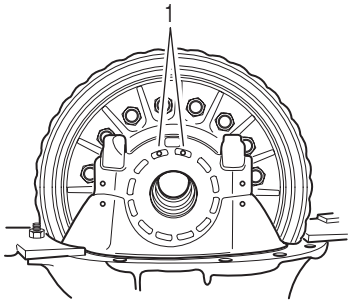
Note: Omit this step if the gear set is to be replaced. If gear set is to be reused, check tooth contact pattern and ring gear backlash before disassembling differential carrier. When checking backlash, a yoke must be installed and torqued to get an accurate reading. Best results are obtained when established wear patterns are maintained in used gearing.

1. Mount differential carrier in repair stand.



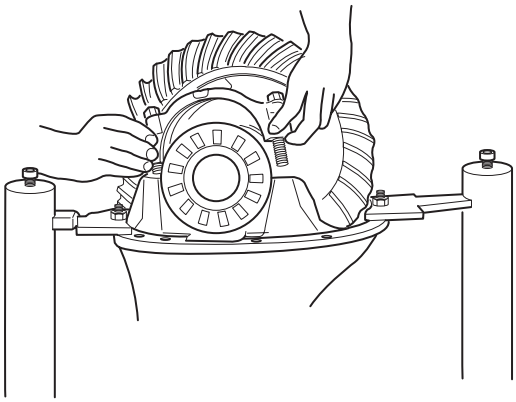
Note: For easier disassembly, loosen but do not remove pinion (self-locking) nut.

2. Punch mark bearing caps. If reusing gear set, also punch mark bearing adjusters for reference during assembly.

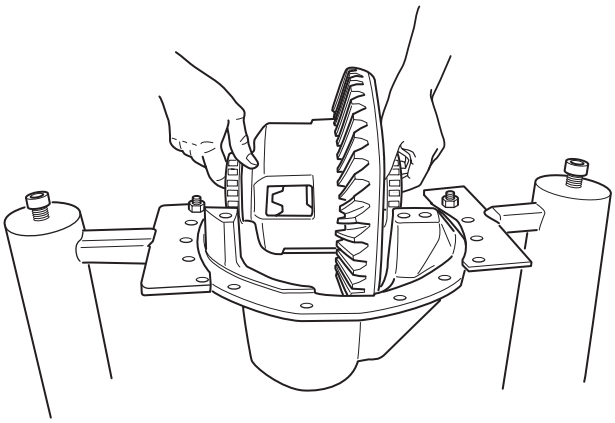


1 - Punch Marks

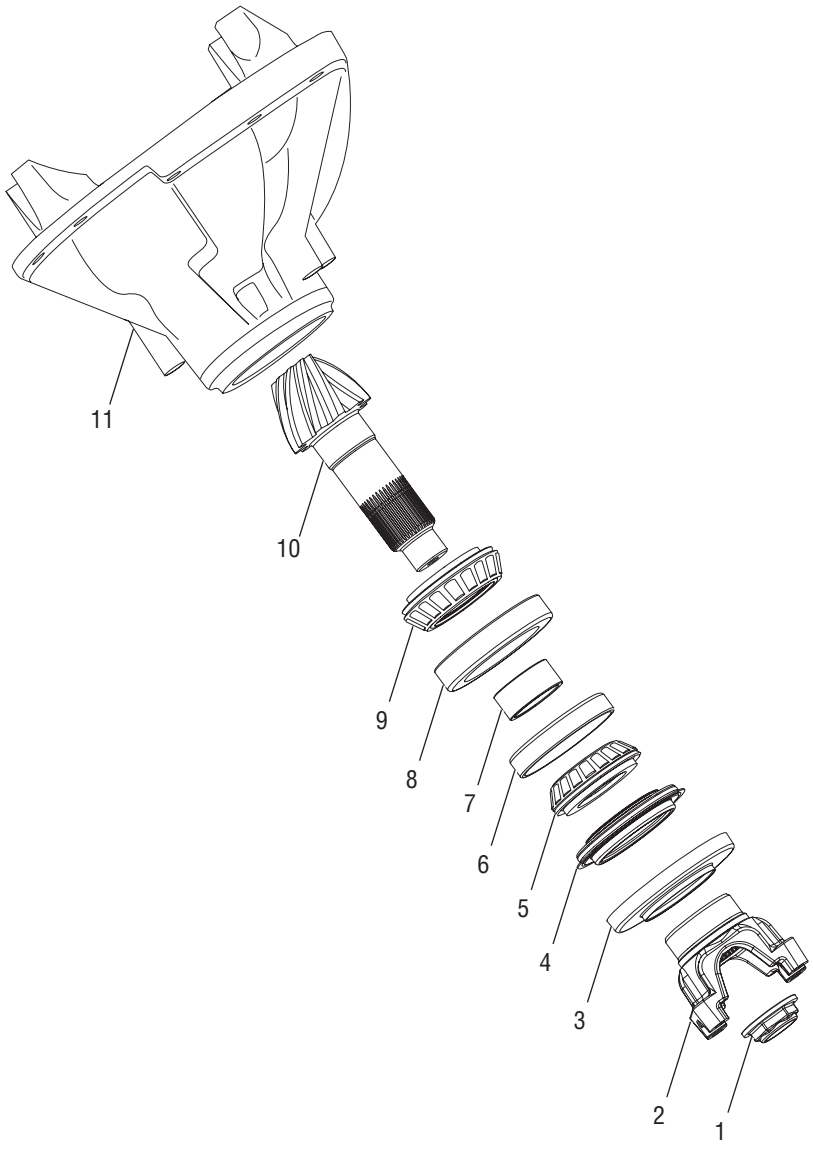
3. Remove capscrews and bearing caps. Back off bearing adjusters and remove adjusters and bearing cups.



4. Lift ring gear and differential assembly out of carrier.



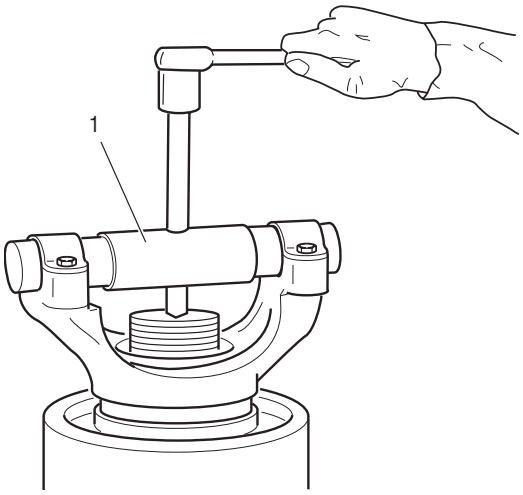
Pinion - Parts Exploded View



1 - Pinion Nut
2 - End Yoke
3 - Slinger
4 - Oil Seal
5 - Outer Pinion Bearing Cone
6 - Outer Pinion Bearing Cup
7 - Pinion Spacer
8 - Inner Pinion Bearing Cup
9 - Inner Pinion Bearing
10 - Drive Pinion
11 - Carrier

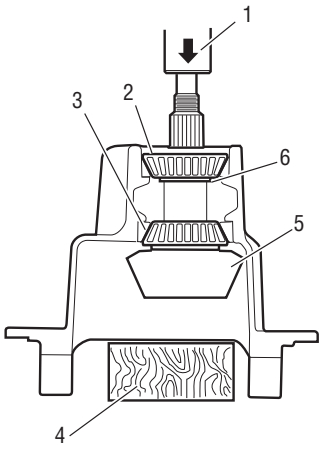
Pinion Removal

1. Remove yoke nut.
2. Remove yoke using a yoke puller service tool.



1 - Yoke puller

3. Remove oil seal.
4. Place carrier in a press with threaded end of pinion face up.
5. Place a wood block under pinion to avoid damage to gear teeth.



1 - Press

2 - Outer bearing

3 - Inner bearing

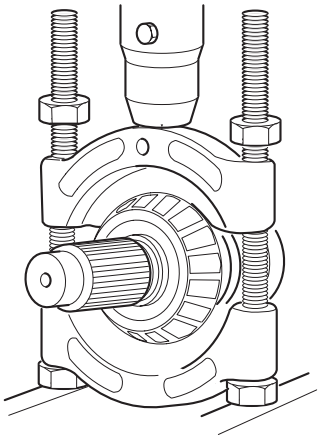
4 - Wood block

5 - Drive pinion

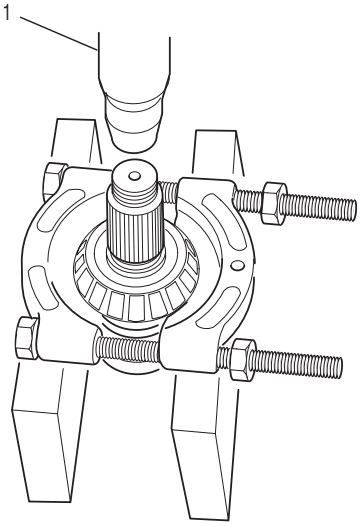
6 - Bearing preload spacer

6. Press pinion through outer bearing and out of carrier casting.
7. Remove bearing preload spacer and save for use in reassembly.
8. Remove inner bearing cone from pinion using a split-type puller. Use two procedure steps to remove each bearing.

a. Mount puller vertically to separate the bearing. This action will force puller halves under bearing and start moving bearing off pinion.



b. Mount puller horizontally to press pinion out of bearing.

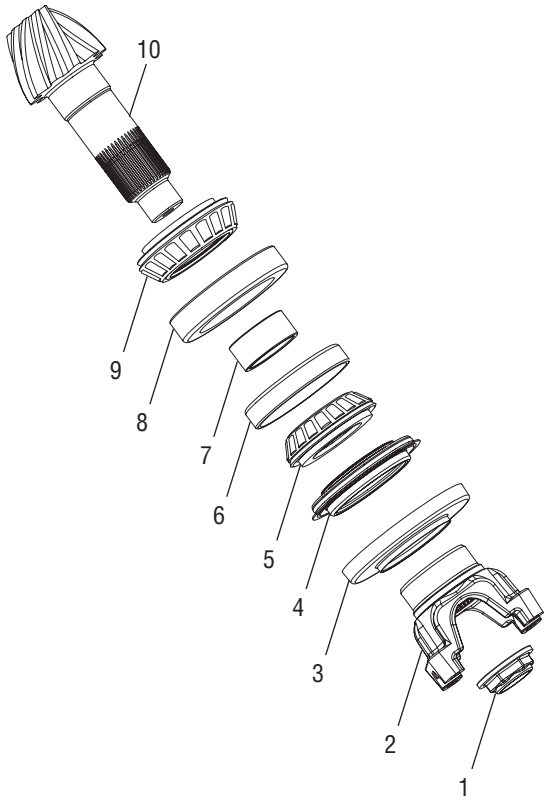


1 - Press

9. If bearings are to be replaced, remove bearing cups from carrier casting at this time. Pinion removal complete.

Drive Pinion

Rear Axle Pinion Assembly - Parts Exploded View



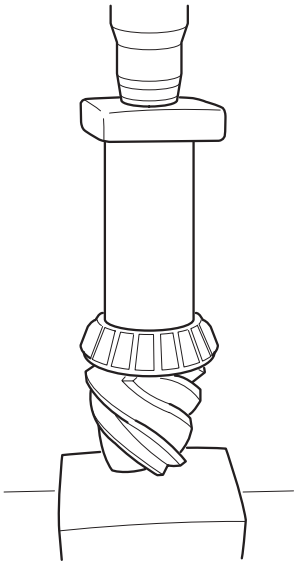
1 - Pinion Nut
2 - End Yoke
3 - Slinger
4 - Oil Seal
5 - Outer Pinion Bearing Cone
6 - Outer Pinion Bearing Cup
7 - Pinion Spacer
8 - Inner Pinion Bearing Cup
9 - Inner Pinion Bearing Cone
10 - Drive Pinion

Pinion Installation

Final Buildup

Note: Do not install oil seal in carrier until bearing preload is correctly adjusted.

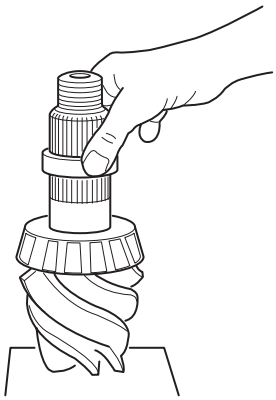
1. Press inner bearing cone on pinion.



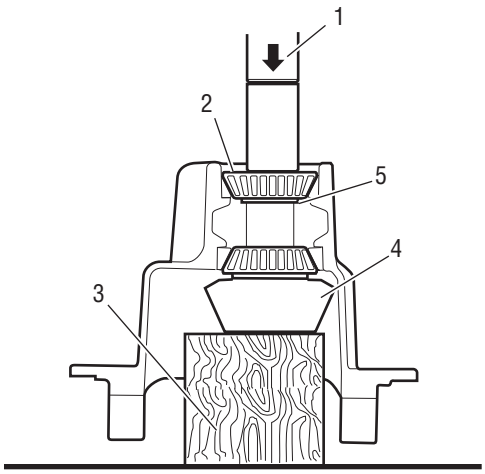
⚠ IMPORTANT

To prevent bearing damage, use suitable sleeve that only contacts inner race of bearing cone.

2. Install preselected bearing spacer.



3. Press inner and outer bearing cups into the carrier until seated. Use a feeler gage (.0015" [.038 mm] approx.) to make sure that bearing cups are fully seated in bearing bores. Apply lubricant to both cup and cone.
4. Place carrier housing in press with the pinion supported by wood block (6" x 6" x 6" [152 x 152 x 152 mm]), so the inner pinion bearing is mated to the cone.



1 - Press

2 - Outer pinion bearing

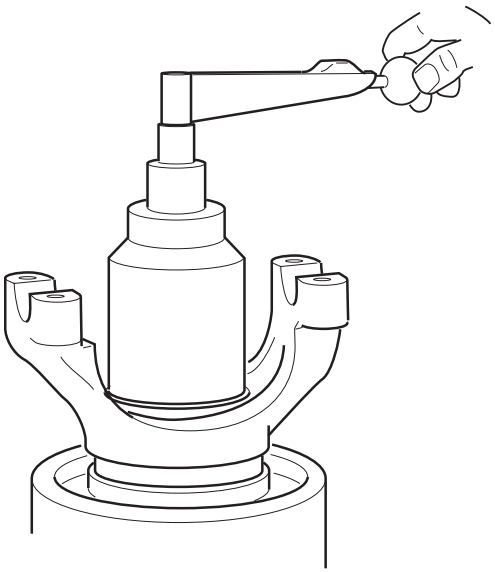
3 - Wood block

4 - Drive pinion

5 - Bearing preload spacer

5. Press outer bearing onto pinion until completely seated. Rotate carrier during seating process.
6. Use torque multiplier and torque pinion nut to 710-1040 lbs. ft. (848-1410 N•m).

7. Measure torque to rotate the pinion with an inch-pound torque wrench. Torque measurements should be taken every fourth (4th) revolution and should read between 34-42 in.lbs. of bearing preload.



Note: If bearing preload does not fall within allowed limits, preload can be increased by using a thinner spacer and decreased by using a thicker spacer.

Always measure each spacer before assembly to ensure correct thickness.

8. Repeat process until torque to rotate is between 34-42 in. lbs. After proper preload is achieved, remove yoke and install new seal with proper service tool.

⚠ CAUTION

Do not use any silicone or permatex-type bore sealant with this seal.

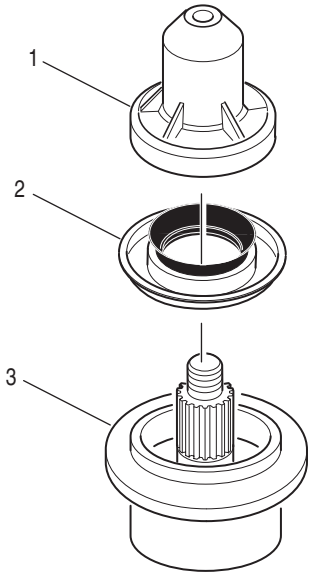
9. Remove the new seal from its package and install with the proper driver:
R-Pinion-Use drive #126917 only

⚠ WARNING

Due to the resiliency of the plastic driver, hammer rebound may occur when the seal is seated. Keep clear of the hammer rebound path!

10. Handle the seal by its outside diameter avoiding any contact with the seal lips. During installation, use the proper driver to make sure that the seal is mounted properly.

11. Use a rubber mallet to drive the seal tool in until the flange bottoms on the housing cover bore face. The flange will locate the seal at the proper depth.



12. Install end yoke.

Note: Spicer recommends that new torque prevailing nuts be used.

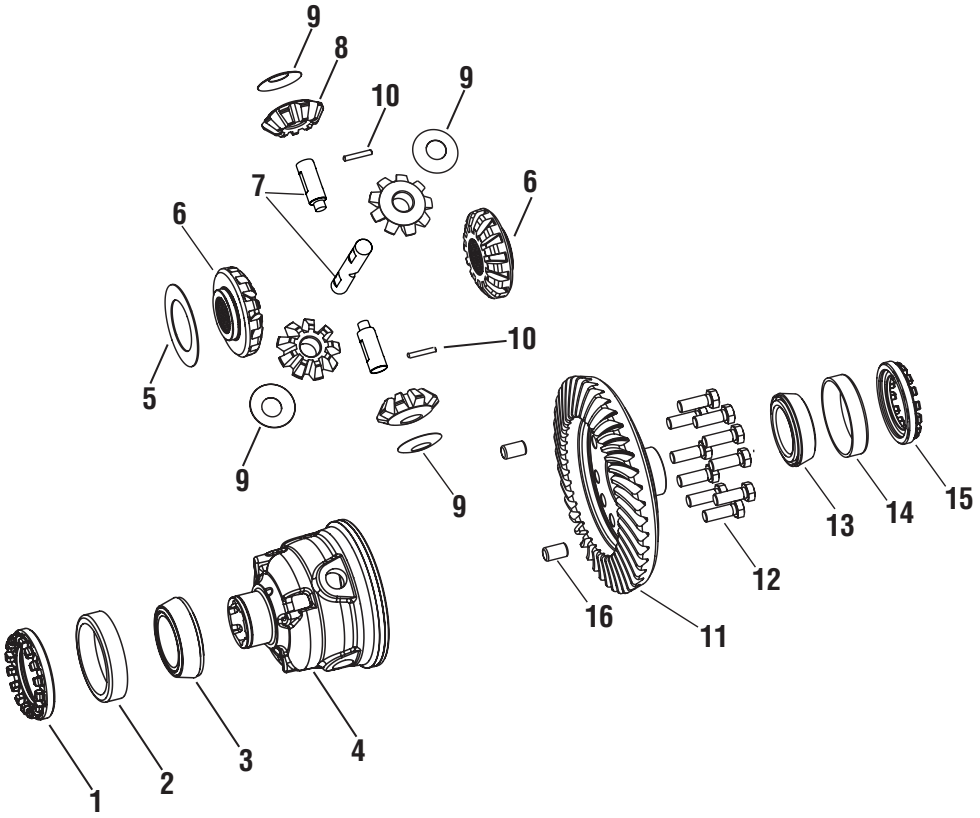
13. Use torque multiplier and torque pinion nut to 710-1040 lbs. ft. (848-1410 N•m).

1 - Seal Driver

2 - Oil Seal

3 - Pinion Cage

Wheel Differential Assembly - Parts Exploded

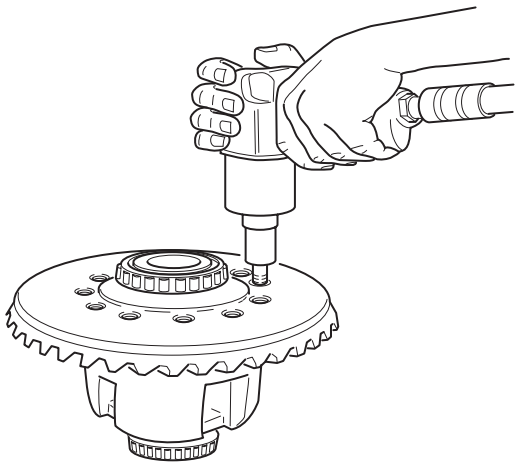


1 - Diff. Case Bearing Adjuster
2 - Diff. Bearing Cup
3 - Diff. Case Bearing Cone
4 - Differential Case
5 - Side Gear Thrust Washer
6 - Side Gear
7 - Differential Shaft
8 - Side Pinion
9 - Side Pinion Thrust Washer
10 - Pin
11 - Ring Gear
12 - Ring Gear Bolt
13 - Ring Gear Bearing Cone
14 - Ring Gear Bearing Cup
15 - Ring Gear Bearing Adjuster
16 - Locating Dowels

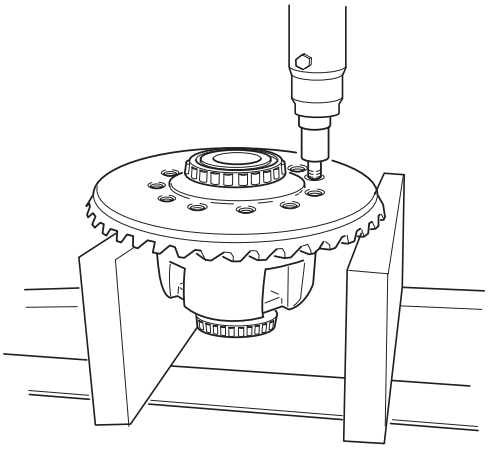
Disassemble, Overhaul, and Assemble Wheel Differential

Disassemble Wheel Differential

1. Remove capscrews fastening ring gear to differential case.



2. The ring gear to differential case interface is a press fit. Place the assembly in a press with the case facing downward. Support the assembly on eitiher side of the ring gear. Thread a capscrew back into one of the case holes by hand. Press down on the head of the capscrew, you may need to press in more than one position to free the ring gear from the case.



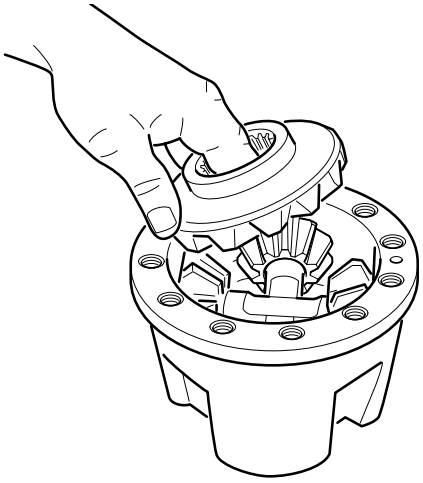
⚠ IMPORTANT

Do not press on the wheel differential shaft to free the ring gear from the case. Pressing on the wheel differential shaft may cause it to bend and/or fatigue.

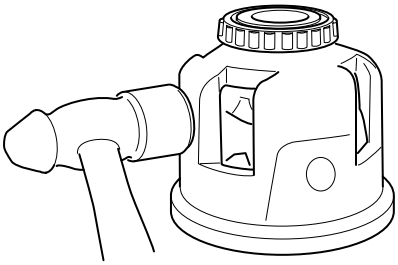
⚠ CAUTION

The differential case and gears will fall after separation. Support the case so that it will not cause damage to the differential or bodily injury.

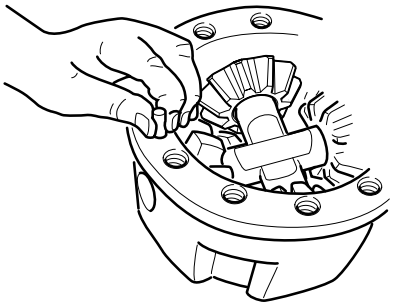
3. Remove the outer side gear.



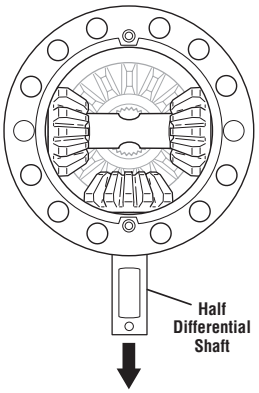
4. Remove the differential shaft locking pins by turning the differential case opening facing down. Use a hammer to lightly tap on the side of the case to free the locking pins.



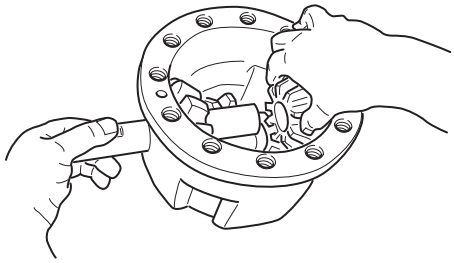
5. The locking pins are slip fit and should fall from the case easily.



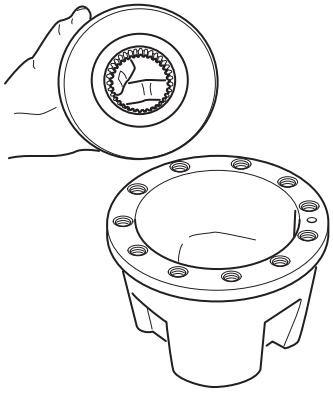
6. Remove the half shafts first and then remove their side pinions and thrust washers.



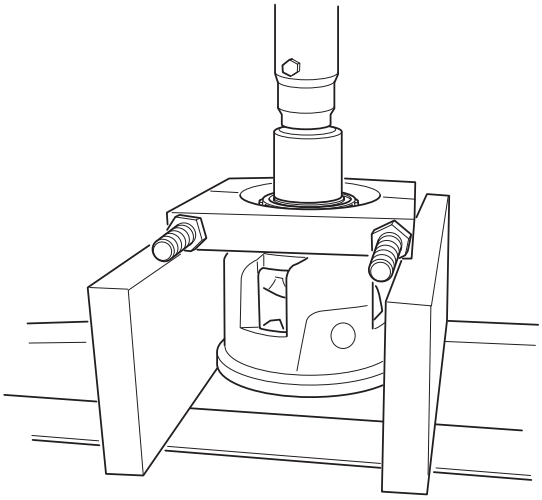
7. Remove the full shaft, side pinions and thrust washers.



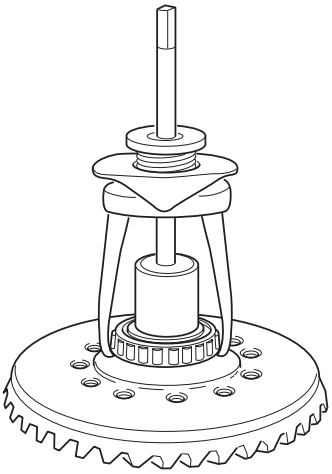
8. Remove inner side gear and thrust washer.



9. Remove bearing cones from ring gear and differential case in two steps:
   A. Mount puller vertically to split bearing. This action will start moving the bearing off case and gear.

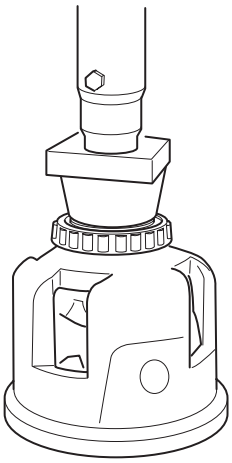


   B. Mount puller horizontally to remove cone.

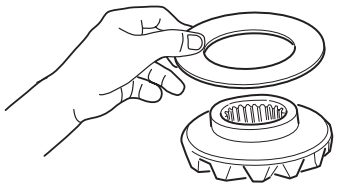


Assemble Wheel Differential

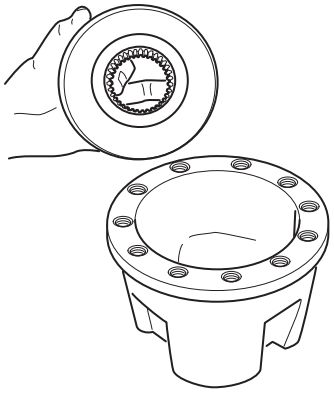
10. Press new bearing cone on the differential case.



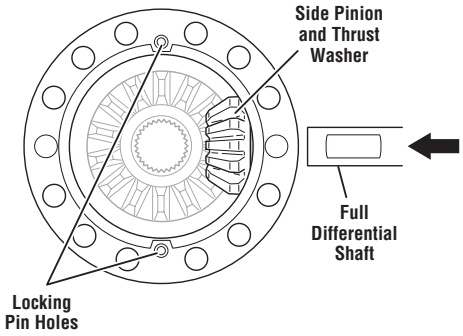
11. Place thrust washer on the side gear. Lubricate both sides of the thrust washer before installing.



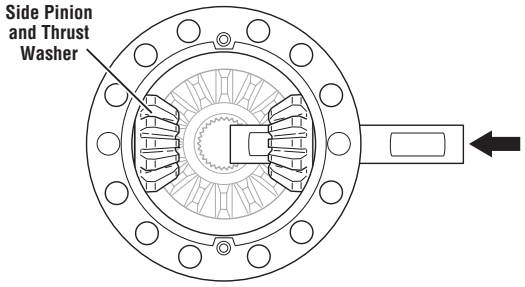
12. Install the side gear and thrust washer in the differential case.



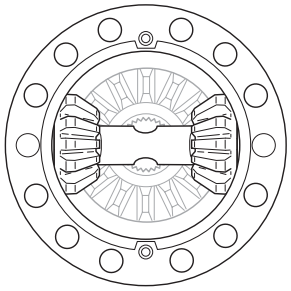
13. Start the full differential shaft into the shaft bores in the case that does not have a locking pin hole.



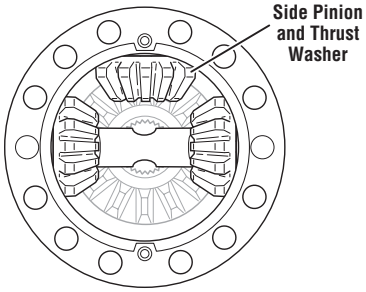
14. Install a side pinion and thrust washer and push the shaft through the side pinion.



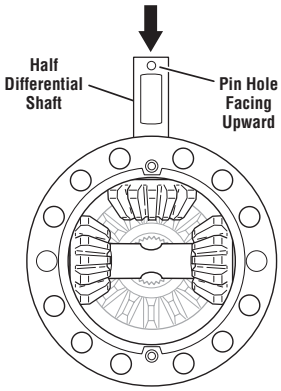
15. Install the side pinion and thrust washer to the other side of the full shaft.



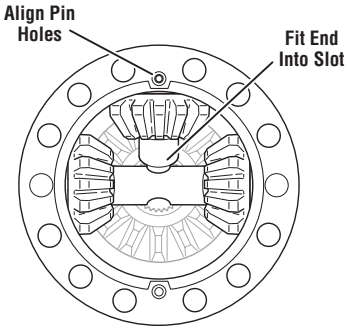
16. Install a side pinion and thrust washer on the half shaft side.



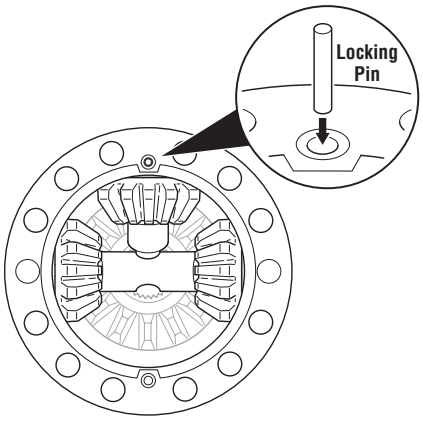
17. Install the half shaft so that the pin is facing upward and push it in until it stops.



18. The end of the half shaft should fit into the slot of the full shaft at the same time as the hole in the case lines up with the hole in the half shaft.

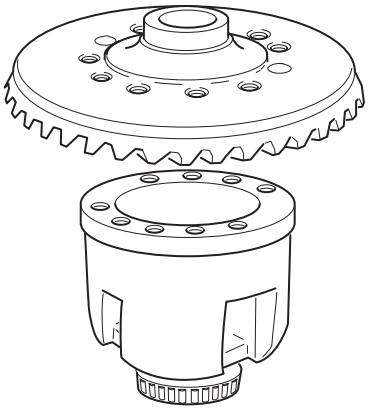


19. Install the locking pins to both sides of the differential case.

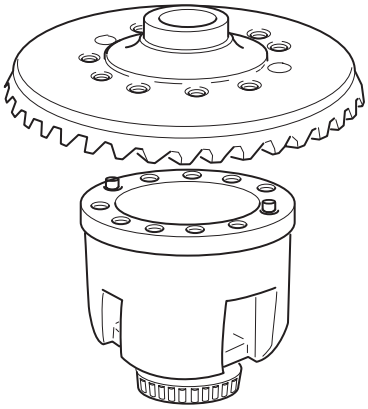


20. Install outer side gear.

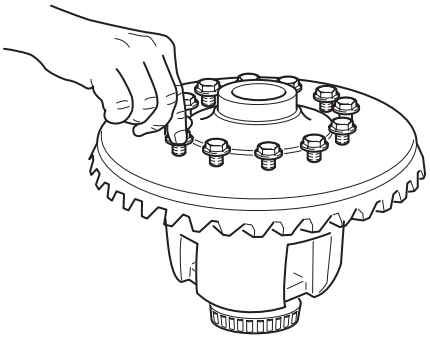
Note: No thrust washer is used at this location.



21. Lower the ring gear onto the case assembly aligning the locking dowels.



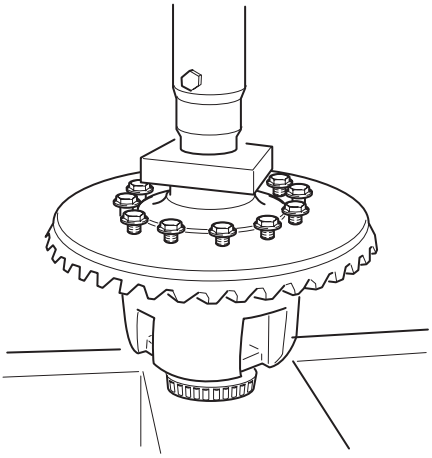
22. Install and hand-tighten all new ring gear capscrews.



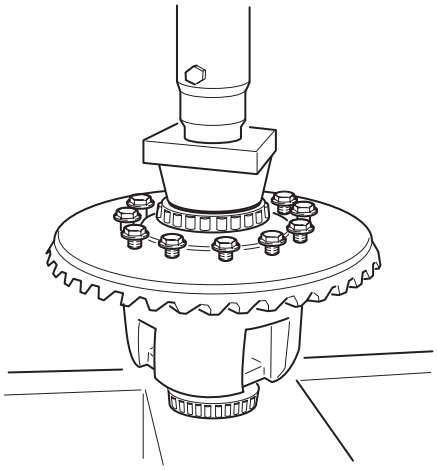
23. The interface of the ring gear to differential case is a press fit. Put the assembly in a press with the ring gear facing upward. Make certain that the ring gear is flush and square to the differential case before pressing. Press until ring gear bottoms out on the case.

⚠ IMPORTANT

DO NOT use the capscrews to draw the ring gear into place. Only use a press.

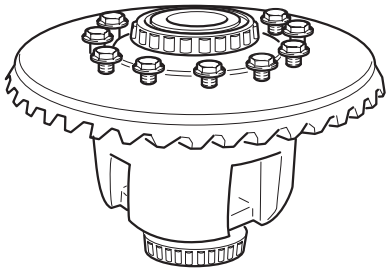


24. Press new ring gear bearing cone.

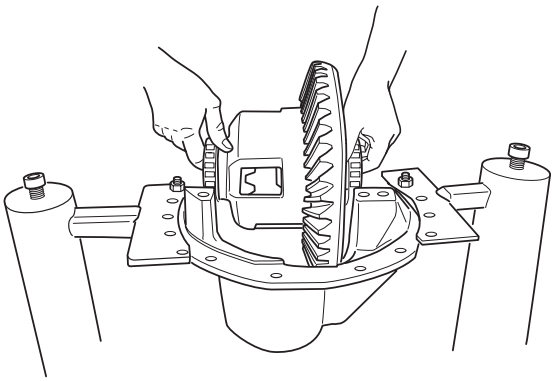


⚠ IMPORTANT

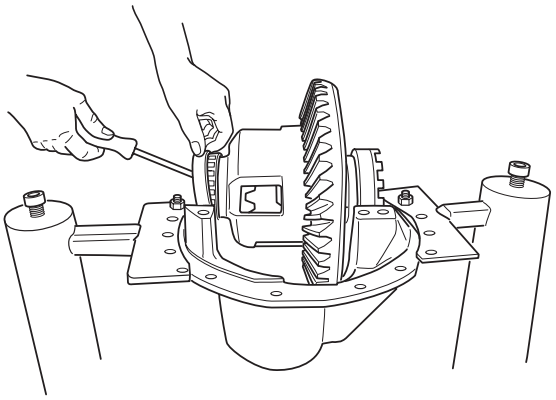
When pressing differential case bearing cones, note that the bearing is beyond flush with the top of the case. The cone must be fully seated. To prevent bearing damage, use suitable sleeve that only contacts the inner race of the cone. A used bearing race would be a suitable tool. This tool should have a slit cut if the ID is the same as the bearing boss OD.



25. Tighten and torque ring gear capscrews in an alternating pattern. 435-465 lbs. ft. (589-630 N•m).
26. Install differential case assembly into carrier. Be careful not to damage the differential bearings lowering the assembly.



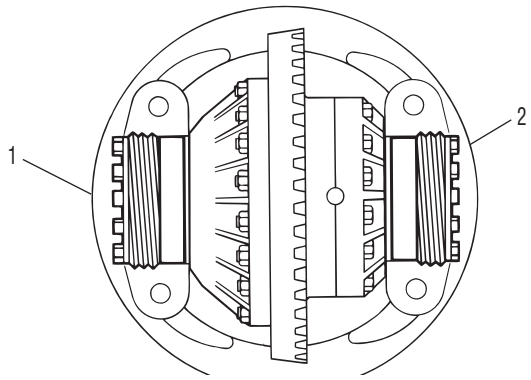
27. Lubricate the differential bearings and install bearing cups and differential bearing adjusters.



Measure and Adjust Carrier Assembly

Adjust Backlash and Preload

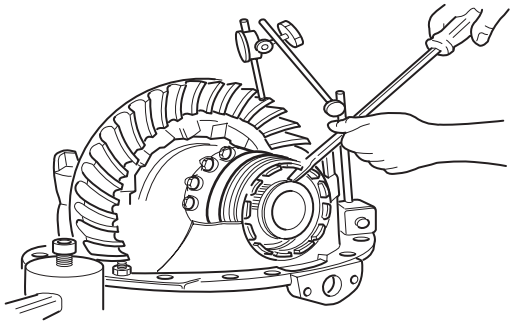
1. Turn the flange half-bearing adjuster in until the ring gear contacts the pinion (zero backlash) then back the adjuster out two (2) notches from the adjuster lugs.



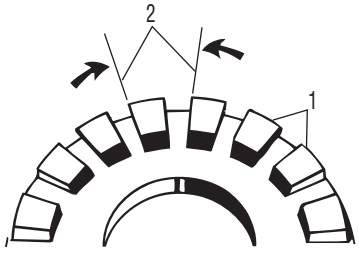
1 - Flange half

2 - Plain half

2. Tighten the plain half-adjuster until the bearing cup just starts to turn, this is a zero bearing preload.



3. Tighten the plain half-adjuster two lug notches. Start with the notch at the top, count two notches counterclockwise on the adjuster, turn the adjuster so that the notch is facing straight up. You now have a two-notch preload.



1 - Lugs

2 - One notch

4. Use a rubber mallet to make certain that both bearing adjusters are fully seated.
5. Measure backlash. Make sure it is within specification of .008"–.018" (.15-.46 mm).

TIP: To give yourself room to adjust contact pattern, set it between .012"–.014" (.30-.36 mm).

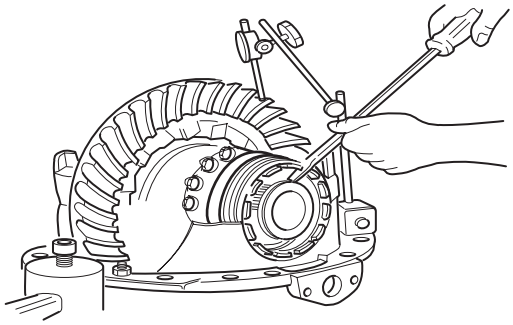
Change Backlash Setting

If you have too much backlash, the ring gear needs to move closer to the pinion. Back off the plain half-adjuster, counting the number of notches you back it off (each notch equals about .003" [.08 mm] of backlash).

⚠ IMPORTANT

In order to maintain the differential bearing preload, you will need to turn the flange half-bearing adjuster the same amount in the same direction. If you need more backlash, reverse this procedure.

1. Install carrier bearing caps and torque carrier cap bolts to 350-428 lbs. ft. (475-580 N•m).
2. **Recheck backlash:** If the bearing adjusters were not in straight or fully seated, the backlash will change.
   a. **Used Gearing:** Reset to backlash recorded before disassembly.
   b. **New Gearing:** Backlash should be between .008” and .018" (.15-.46 mm).

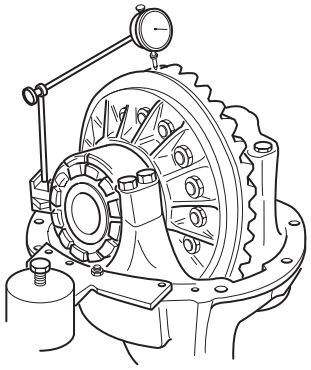


3. Check ring gear tooth contact pattern. Paint ring gear teeth and check tooth contact pattern. Correct tooth patterns, see "Adjust Tooth Contact Pattern."
4. Install bearing adjuster cotter pins.

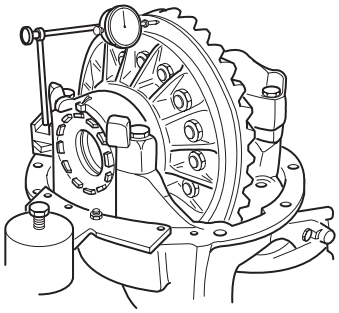
Measure Ring Gear Runout

Measure Ring Gear Total

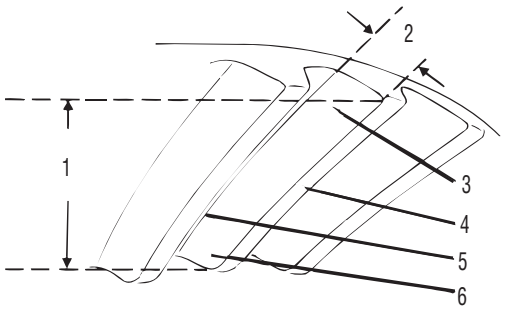
1. Measure ring gear total radial runout. (Indicator reading should not exceed .010" [.25 mm]).



2. Measure ring gear total backface runout. (Indicator reading should not exceed .010" [.25 mm]).



Adjust Ring and Pinion Tooth Contact Pattern

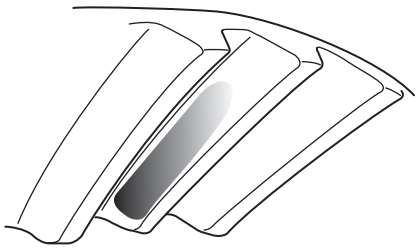


1 - Face width
2 - Tooth depth
3 - Heel
4 - Top land
5 - Root
6 - Toe

1. Identify if new or used gearing.
2. Check tooth contact pattern (new or used gearing).

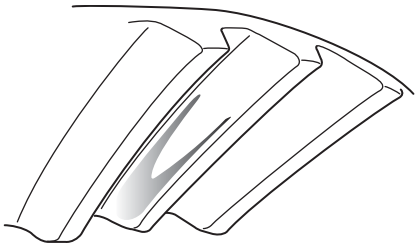
New Gearing - Correct Pattern

- Paint six ring gear teeth 180° apart and roll the gear to obtain a contact pattern. The correct pattern is slightly below center on the ring gear tooth with lengthwise contact up off the toe. The length of the pattern in an unloaded condition is approximately one-half (1/2) to two-thirds (2/3) of the ring gear tooth in most models and ratios.
- The pattern could vary in length and should cover half (1/2) of the tooth or more (face width). The pattern should be evenly centered between tooth top land and root and should be up off the tooth toe.



Used Gearing - Correct Pattern

- Used gearing will not usually display the square, even contact pattern found in new gear sets. The gear will normally have a “pocket” at the heal end of the gear tooth. The more use a gear has had, the more the line becomes the dominant characteristic of the pattern.
- Adjust used gear sets to display the same contact pattern observed before disassembly. A correct pattern is up off the toe and centers evenly along the face width between the top land and root. Otherwise, the length and shape of the pattern are highly variable and is considered acceptable as long as it does not run off the tooth at any point.



1 - Pattern along the face width could be longer

Adjust Contact Pattern

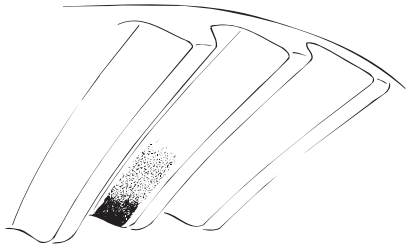
- If necessary, adjust the contact pattern by changing the ring gear position.
- Ring gear position controls the backlash. This adjustment moves the contact pattern along the face width of the gear tooth.

Note: This is a shimless pinion designed carrier. If the pattern shows an incorrect pinion cone position, check to make sure the inner pinion cup is fully seated. Use a feeler gauge.

Adjust Ring Gear Position (Backlash)

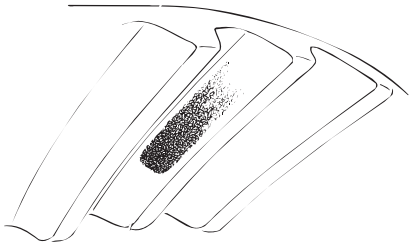
If the ring gear pattern shows incorrect face width contact, change backlash by adjusting the ring gear.

If the pattern is too close to the edge of the tooth toe, move the ring gear away from the pinion to increase backlash.



1. Loosen the bearing adjuster on the teeth side of the ring gear several notches.
2. Loosen the opposite adjuster one notch.
3. Return to adjuster on teeth side of the ring gear and tighten adjuster until it contacts the bearing cup.
4. Continue tightening the same adjuster two (2) or three (3) notches and recheck backlash.

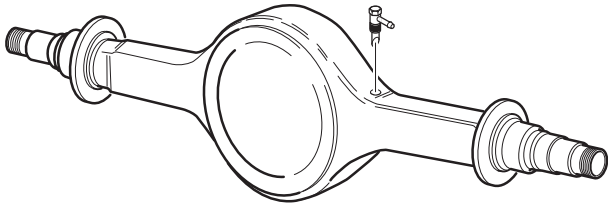
If the pattern is concentrated at the heel (too far up the tooth), move the ring gear toward the pinion to decrease backlash.



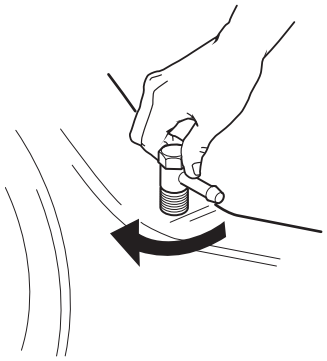
5. Loosen the bearing adjuster on the teeth side of the ring gear several notches.
6. Tighten the opposite adjuster one notch.
7. Return to adjuster on teeth side of ring gear and tighten adjuster until it contacts the bearing cup.
8. Continue tightening the same adjuster two (2) or three (3) notches and recheck backlash.

Install Axle Housing Breather

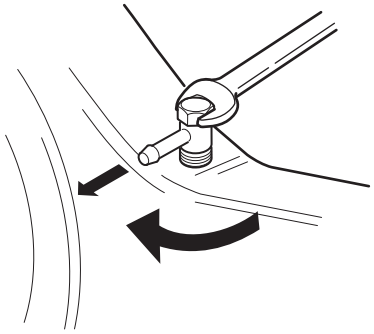
1. Install fitting in breather hole.



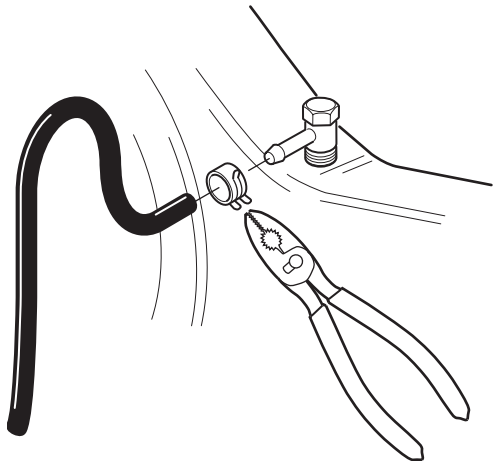
2. Tighten fitting finger tight.



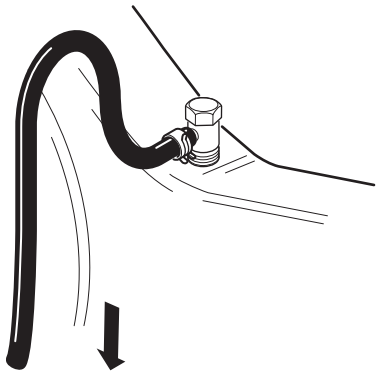
3. Torque to 5 lbs. ft. (7 N•m) and align the nose of the breather to the rear.



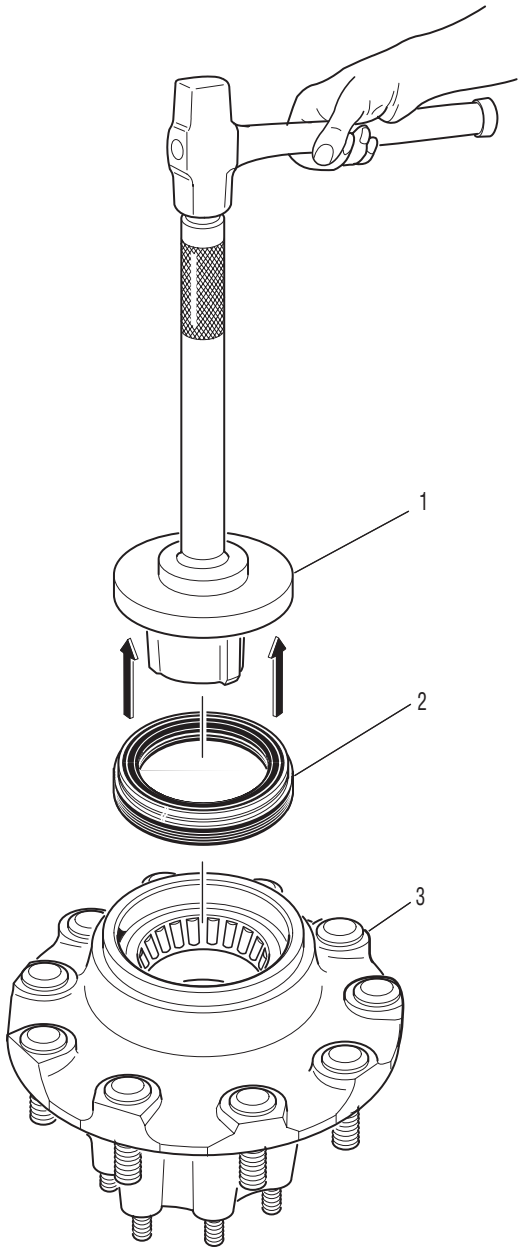
4. Insert hose onto fitting, long end down.



5. Push hose firmly against fitting. Rotate hose to point down.



Wheel End Seal - Parts Exploded View



1 - Installation tool
2 - Seal
3 - Rear hub

Remove and Overhaul Wheel End Seal

⚠ WARNING

Never work under a vehicle supported by only a jack. Always support vehicle with stands. Block the wheels and make sure the vehicle will not roll before releasing the brakes.

⚠ WARNING

Wheel end seals can be easily damaged during handling. Leave the seal in its package until installation to prevent damage or contamination.

1. Remove outer nut and locking washer.
2. Remove inner nut.
3. Remove outer bearing and wheel.
4. Remove oil seal.
5. Remove inner bearing.
6. Inspect spindle journal and hub bore for scratches or burrs. Recondition with an emery cloth as required.

Note: Deep gouges can be repaired by filling gouge with hardening gasket cement and smoothing with emery cloth.

7. Clean hub cavity and bearing bores before reassembly. Be sure to remove contaminants from all recesses and corners.
8. Clean bearings thoroughly with solvent and examine for damage. Replace damaged or worn bearings.

⚠ IMPORTANT

Always use the seal installation tool specified by the seal manufacturer. Using an improper tool can distort or damage the seal and cause premature seal failure.

Install Wheel End Seal

1. Before installation, lubricate the following with the same lubricant used in the axle sump.
   - Inner bearing.
   - Wheel seal (follow the directions provided by the seal supplier).
2. Place seal on installation tool.
3. Drive seal with installation tool onto hub.

Adjust Wheel Bearing

⚠ WARNING

Do not mix spindle nuts and lock washers from different systems. Mixing spindle nuts and lock washers can cause wheel separation.

Note: The lock washer for a four-piece tang/dowel-type wheel nut system is thinner than the lock washer for a three-piece tang-type wheel nut system and is not designed to bear against the inner nut.

1. Inspect the spindle and nut threads for corrosion and clean thoroughly or replace as required.

Note: Proper assembly and adjustment is not possible if the spindle or nut threads are corroded.

2. Inspect the tang-type washer (if used). Replace the washer if the tangs are broken, cracked, or damaged.
3. Install the hub and drum on the spindle with care to prevent damage or distortion to the wheel seal.

⚠ CAUTION

A wheel dolly is recommended during installation to make sure that the wheel seal is not damaged by the weight of the hub and drum. Never support the hub on the spindle with just the inner bearing and seal. This can damage the seal and cause premature failure.

4. Completely fill the hub cavity between the inner and outer bearing races with the same lubricant used in the axle sump.
5. Before installation, lubricate the outer bearing with the same lubricant used in the axle sump.

Note: Lubricate only with **clean** axle lubricant of the same type used in the axle sump. Do not pack the bearings with grease before installation. Grease will prevent the proper circulation of axle lubricant and may cause wheel seal failure.

6. Install the outer bearing on the spindle.
7. Install the inner nut on the spindle. Tighten the inner nut to 200 lbs. ft. (271 N•m) while rotating the wheel hub.

⚠ CAUTION

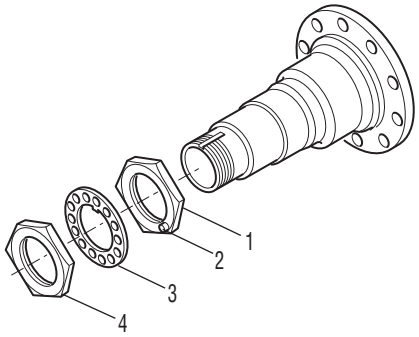
Never use an impact wrench to adjust wheel bearings. A torque wrench is required to assure the nuts are properly tightened.

8. Back off the inner nut one full turn. Rotate the wheel hub.
9. Retighten the inner nut to 50 lbs. ft. (68 N•m) while rotating the wheel hub.
10. Back off the inner nut exactly 1/4 turn.

Note: This adjustment procedure allows the wheel to rotate freely with 0.001" -.005" (0.025 mm–0.127 mm) end-play.

11. Install the correct lock washer for the wheel nut system being used.

Three-piece Dowel-type Lock Washer System



1 - Inner nut

2 - Dowel pin

3 - Dowel-type lock washer

4 - Outer nut

- Install the Dowel-type lock washer on the spindle.

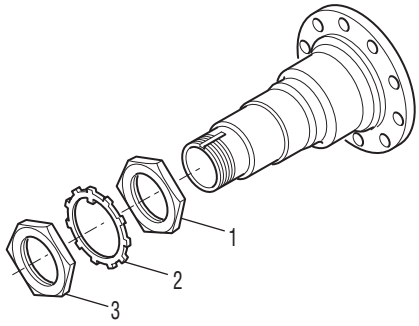
Note: If the dowel pin and washer are not aligned, remove washer, turn it over and reinstall. If required, **loosen** the inner nut just enough for alignment.

⚠ IMPORTANT

Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

- Install the outer nut on the spindle and tighten to 350 lbs. ft. (475 N•m).
- Verify end-play, see “Verify Wheel End Play Procedure."

Three-piece Tang-type Lock Washer System



1 - Inner nut

2 - Tang-type lock washer .123” thick

3 - Outer nut

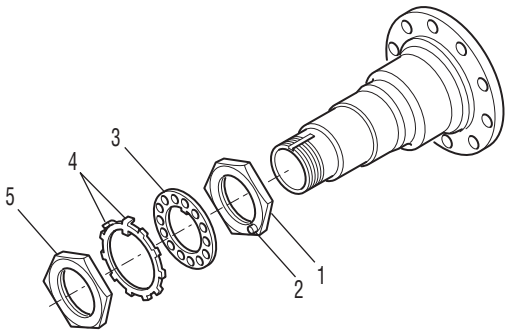
- Install the Tang-type lock washer on the spindle.

⚠ IMPORTANT

Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

- Install the outer nut on the spindle and tighten to 250 lbs. ft. (339 N•m).
- Verify end-play, see “Verify Wheel End Play Procedure."
- After verifying end-play, secure wheel nuts by bending one of the locking washer tangs over the outer wheel nut and another tang over the inner wheel nut.
- Go to step 12.

Four-piece Tang/Dowel-type Lock Washer System



1 - Inner nut

2 - Dowel pin

3 - Dowel-type lock washer

4 - Tang-type lock washer .0478” thick

5 - Outer nut

- Install the Dowel-type lock washer on the spindle.

Note: If the dowel pin and washer are not aligned, remove washer, turn it over and reinstall. If required, loosen the inner nut just enough for alignment.

⚠ IMPORTANT

Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

- Install the Tang-type lock washer on the spindle.
- Install the outer nut on the spindle and tighten to 250 lbs. ft. (339 N•m).
- Verify end-play, see “Verify Wheel End Play Procedure."
- After verifying end-play, secure the outer nut by bending (180° apart) two opposing tangs of the locking washer over the outer nut.

12. Install the following:
    - New gasket at axle shaft flange.
    - Axle shaft.
    - Axle flange nuts and tighten to specified torque.
13. Lubricate axle wheel ends.

Wheel End

Verify Wheel End-play Procedure

Verify end-play meets specification using a dial indicator. An indicator with .001" (.03 mm) resolution is required. Wheel end-play is the free movement of the tire and wheel assembly along the spindle axis.

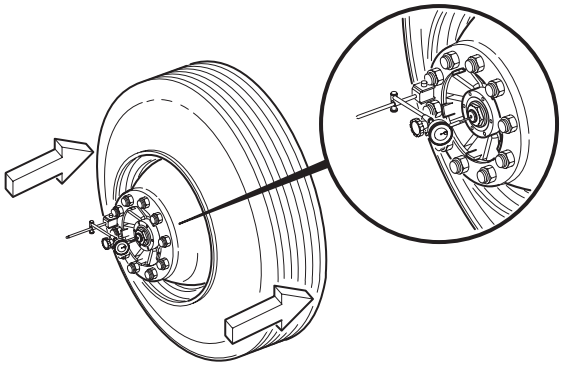
Correct end-play is .001-.005” (.025-.125 mm).

1. Attach a dial indicator with its magnetic base to the hub or brake drum as shown below.
2. Adjust the dial indicator so that its plunger or pointer is against the end of the spindle with its line of action approximately parallel to the axis of the spindle.
3. Grasp the wheel assembly at the 3 o’clock and 9 o’clock positions. Push the wheel assembly in and out while oscillating it to seat the bearings. Read bearing end-play as the total indicator movement.

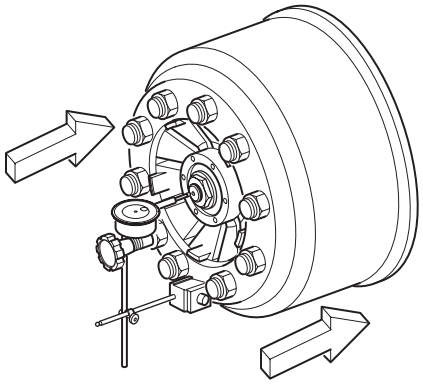
⚠ CAUTION

If end-play is not within specification, readjustment is required.

Adjust End-play with Tire and Wheel Assembly



Adjust End-play with Wheel Hub



With indicator mounted at bottom, push / pull at sides of drum.

Readjust Wheel End-play Procedure

Excessive End-play: If end-play is greater than .005" (.127 mm), remove the outer nut and pull the lock washer away from the inner nut, but not off the spindle. Tighten the inner nut to the next alignment hole of the dowel-type washer (if used). Reassemble the washer and retorque the outer nut. Verify end-play with a dial indicator.

Insufficient End-play: If end-play is not present, remove the outer nut and pull the lock washer away from the inner nut, but not off the spindle. Loosen the inner nut to the next adjustment hole of the dowel-type washer (if used). Reassemble the washer and retorque the outer nut. Verify end-play with a dial indicator.

Fine Tuning the End-play: If, after performing the readjustment procedures, end-play is still not within the .001"-.005” (.025-127 mm) range, disassemble and inspect the components. If parts are found to be defective, replace the defective parts, reassemble and repeat wheel bearing adjustment procedure. Verify end-play with a dial indicator.

Lubricate Wheel End

⚠ IMPORTANT

Before operating the axle, the wheel hub cavities and bearings must be lubricated to prevent failure.

When wheel ends are serviced, follow Spicer's wheel end lubrication procedure before operating the axle.

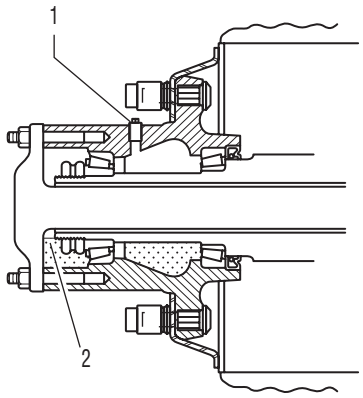
Spicer axles may be equipped with either of two (2) wheel-end designs:

- Wheel ends **with** an oil fill hole.
- Wheel ends **without** an oil fill hole .

Wheel Ends with an Oil Fill Hole

1. Remove the oil fill plug.
2. Pour half (1/2) a pint of axle sump lubricant into each hub through the wheel end fill hole.
3. Install oil fill plug and tighten to specified torque.

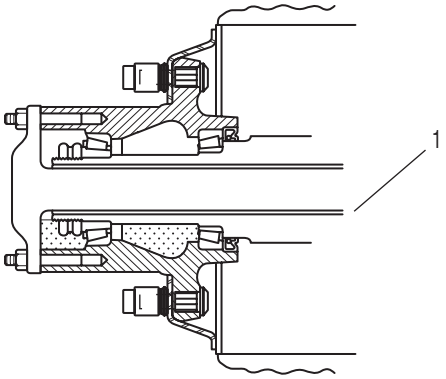
Wheel End with Oil Fill Hole



1 - Wheel end oil fill hole

2 - Proper lubricant level

Wheel End without Oil Fill Hole

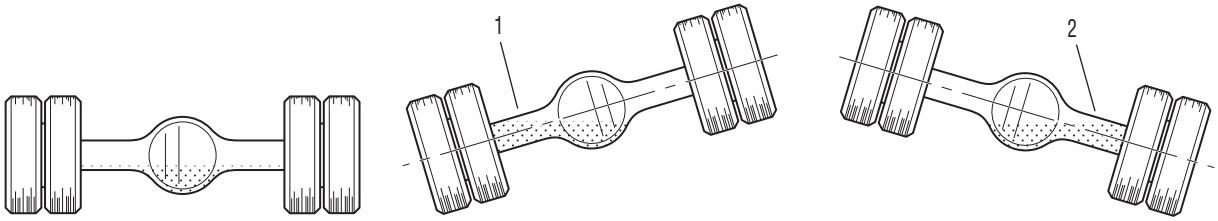


1 - Lubricant flow from sump

Wheel Ends without Oil Fill Hole

1. With axle level and wheel ends assembled, add lubricant through filler hole in carrier until fluid is level with the bottom of filler hole.
2. Raise the right side of the axle six (6) inches (152 mm) or more. Hold axle in this position for one (1) minute.
3. Lower the right side.
4. Raise the left side of the axle six (6) inches (152 mm) or more. Hold axle in this position for one (1) minute.
5. Lower the left side.
6. With axle on a level surface, add lubricant through carrier oil filler hole until fluid is level with the bottom of the hole.

Note: Axles without wheel end fill holes will require approximately 2.5 additional pints of lubricant to bring the lube level even with the bottom of fill hole.



1 - Oil will run into wheel end

2 - Oil will run into wheel end

Lubrication

The ability of a drive axle to deliver quiet, trouble-free operation over a period of years is largely dependent upon the use of good-quality gear lubrication in the correct quantity. The most satisfactory results can be obtained by following the directions contained in this manual.

The following lubrication instructions represent the most current recommendations from the Axle & Brake Division of Dana.

Approved Lubricants

General - Gear lubrications acceptable under military specification (MILSPEC) MIL-L-2105D (Lubricating Oils, Gear, Multipurpose) are approved for use in Spicer Drive Axles. The MIL-L-2105D specification defines performance and viscosity requirements for multigrade oils. It supersedes both MIL-L-2105B, MIL-L-2105C and cold weather specification MIL-L-10324A. This specification applies to both petroleum-based and synthetic based gear lubricants if they appear on the most current "Qualified Products List" (QPL-2105) for MIL-L-2105D.

Note: The use of separate oil additives and/or friction modifiers are not approved in Spicer Drive Axles.

Synthetic Based - Synthetic-based gear lubricants exhibit superior thermal and oxidation stability, and generally degrade at a lower rate when compared to petroleum-based lubricants. The performance characteristics of these lubricants include extended change intervals, improved fuel economy, better extreme temperature operation, reduced wear and cleaner component appearance. The family of Spicer gear lubricants represents a premium quality synthetic lube which fully meets or exceeds the requirements of MIL-L-2105D. These products, available in both 75W-90 and 80/W-140, have demonstrated superior performance in comparison to others qualified under the MILSPEC, as demonstrated by extensive laboratory and field testing. For a complete list of Spicer-approved synthetic lubricants, contact your local Dana representative. See back cover of this manual for appropriate phone number.

Makeup Lube - Maximum amount of non-synthetic makeup lube is 10%.

Recommendations for Viscosity/Ambient Temperature

The following chart lists the various SAE Grades covered by MIL-L-2105D and the associated ambient temperature range from each. Those SAE grades shown with an asterisk (*) are available in the Spicer family of synthetic gear lubricants.

The lowest ambient temperatures covered by this chart are -40°F and -40°C. Lubrication recommendations for those applications which consistently operate below this temperature range must be obtained through Dana by contacting your local Dana representative.

Grade	Ambient Temperature Range
75W	-40°F to -15°F (-40°C to -26°C)
75W-80	-40°F to 80°F (-40°C to 21°C)
75W-90*	-40°F to 100°F (-40°C to 38°C)
75W-140	-40°F and above (-40°C and above)
80W-90	-15°F to 100°F (-26°C to 38°C)
80W-140*	-15°F and above (-26°C and above)
85W-140	10°F and above (-12°C and above)

* Available in the Spicer family of synthetic gear lubricants.

Lube Change Intervals

This product combines the latest manufacturing and part washing technology. **When filled with a Spicer-approved synthetic lubricant at the factory, the initial drain is not required.**

Change the lubricant within the first 5,000 miles of operation when not using a Spicer-approved synthetic lubricant in either a new axle or after a carrier head replacement. Base subsequent lubricant changes on a combination of the following chart and user assessment of the application and operating environment.

Severe Service Lubrication Change Intervals - Severe service applications are those where the vehicle consistently operates at or near its maximum GCW or GVW ratings, dusty or wet environments, or consistent operation on grades greater than 8%. For these applications, the ON/OFF HIGHWAY portion of the chart should be used. Typical applications are construction, logging, mining and refuse removal.

Note: Clean metallic particles from the magnetic filler plug and drain plugs. Clean or replace the breather yearly to avoid lube contamination due to water ingestion.

Synthetic or Mineral	Lubricant	SAE	Change Interval for Line Haul	Change Interval for Vocational
Synthetic*	SHAES-256	SAE 75W-90	500,000 miles [800,000 Km] or 5 years	120,000 miles (193,000 Km) or 1year
Synthetic**	SHAES-256	SAE 75W-90, 75W-140	250,000 miles (400,000 Km) or 3 years	60,000 miles [96,500 Km] or 1 year
Mineral Base	MIL-L-2105E/J02360, API GL-5 Gear Oil, MIL-PRF-2105E	75W, 75W-90, 75W-140, 80W-90, 85W-140	120,000 miles [193,000 Km] or 1 year	60,000 miles [96,500 Km] or 1 year

* Axles using LMS wheel end system

** Axles using adjustable wheel bearing system

Change Lube

Drain

1. Drain when the lube is at normal operating temperature (150°-200°F [66°-93°C]). It will run freely and minimize the time necessary to fully drain the axle, this insures the axle is flushed.
2. Remove the bottom two carrier to housing capscrews and allow the lube to drain into a suitable container.

Note: Dispose of all used lubricants properly by following disposal methods approved for mineral- or synthetic-based oils.

3. Inspect breather for clogging or corrosion. Clean or replace as necessary.

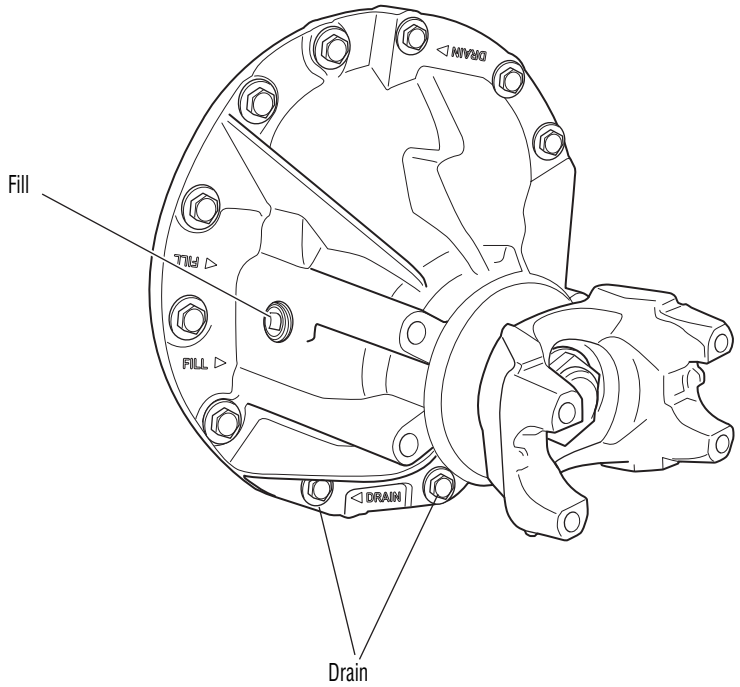
Fill

1. Reinstall bottom two carrier to housing capscrews – use Loctite 270 and torque to 142–158 lbs. ft. (193-214 N•m).
2. Remove the filler hole plug from the side of the carrier and fill the axle with the approved lubricant until level with the bottom of the hole.
3. If wheel ends were removed, follow instructions in the wheel end servicing section.

Always use the filler hole as the final reference. If lube is level with the bottom of the hole, the axle is properly filled.

Note: Lube fill capacities are basic guidelines and will vary based on the angle the axle is installed in a particular chassis. Torque fill plug to 40–60 lbs. ft. (54–82 N•m).

TIP: The axle can be filled through the axle housing breather hole. Fill until lube level is even with the bottom of filler hole in side of carrier.



Proper Vehicle Towing

Lift the drive wheels completely off of the ground or damage will occur.

⚠ WARNING

Do not lift the front wheels (non-drive wheels). This alters the oil's position in the drive axle, draining it away from the drive pinion and its bearings. If the pinion is rotated under these conditions for any period of time, bearings will overheat resulting in axle damage or failure.

If it is impossible to lift the drive wheels, remove all axle shafts to prevent gear rotation and cap the wheel hubs to prevent loss of lubricant and a possible road hazard. See the following section Proper Vehicle Towing with Wheel Differential Lock for removal procedure.

Torque Chart

Location	Thread Size	Class/Grade	Torque Secifications
Pinion End Nut	M36 x 1.5	10.9	710-1040 lbs. ft. (848-1410 N•m)
Ring Gear to Diff Case Capscrew	M20 x 1.5	10.9	435-465 lbs. ft. (589-630 N•m)
Carrier Cap Capscrew	M20 x 2	10.9	350-428 lbs. ft. (475-580 N•m)
Fill Plug	1 x 1.11.5	–	40-60 lbs. ft. (54-81 N•m)
Carrier to Housing Capscrew	M14 x 2	10.9	142-158 lbs. ft. (193-214 N•m)
Parking Brake Capscrew	M16 x 1.5	10.9	180-220 lbs. ft. (244-298 N•m)

For spec'ing or service assistance, call 1-877-777-5360 or visit our website at www.dana.com

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